Magnetic depth profiles of complex oxide thin films

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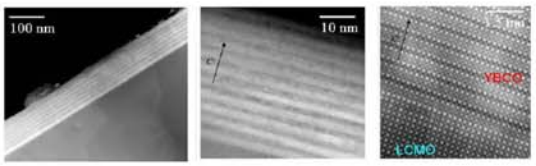
Motivation

- Complex oxides can have wide range of physical properties:
  (anti)ferromagnetism, superconductivity, ferroelectricity, …
- Attractive for building composite systems to study of interactions.
  - ↓ Magnetic and electrical properties can be tailored with doping.
  - ↓ Epitaxial heterostructures possible with sharp interfaces.
- **Polarized Neutron Reflectometry (PNR) provides vital information on layer and interface dependent structural and magnetic properties.**

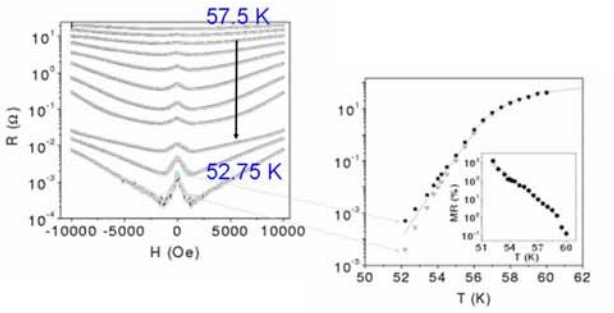


Transmission electron microscopy of $La_{0.7}Ca_{0.3}MnO_3$ / $YBa_2Cu_3O_{7-\delta}$ superlattice

Accomplishments

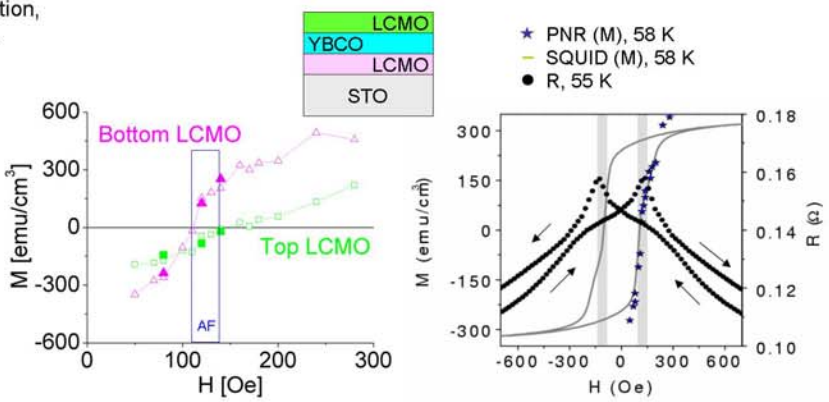
Issue:

- Large MagnetoResistance is measured **during** resistive transition, *but not above it*, in $La_{0.7}Ca_{0.3}MnO_3/YBa_2Cu_3O_{7-\delta}$ superlattices.
- MR is correlated with step in magnetization.



Large **magnetoresistance** peaks along the resistive transition!

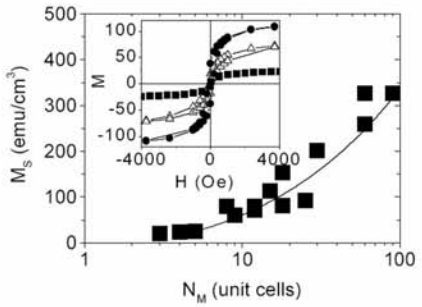
PNR Result:

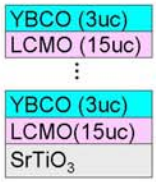


Peak in resistance is coincident with step in the magnetization and region **with AF alignment between LCMO layers.**

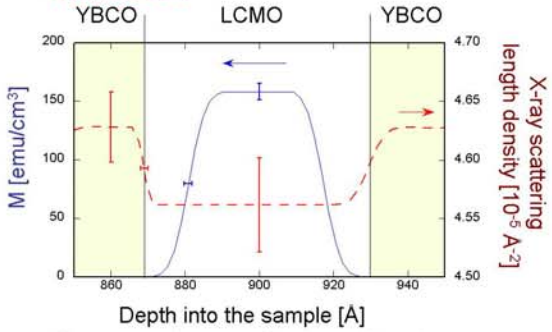
Issue:

- $La_{0.7}Ca_{0.3}MnO_3$ in $La_{0.7}Ca_{0.3}MnO_3/YBa_2Cu_3O_{7-\delta}$ superlattices has a reduced magnetization compared to that of single film (500 emu/cm³), even above T_c





PNR Result:



Suppressed magnetization at interface

Future Directions

Utilize **Polarized Neutron Reflectometry** to determine the magnetic depth profile in films and superlattices.

- ↓ MR effect in LCMO/YBCO heterostructures, artificially controlling coercive fields of LCMO layers.
- ↓ Influence of magnetization on superconducting layer, especially at interface.
- ↓ Digital Synthesis of Complex Oxides (highlight talk & poster, Anand Bhattacharya *et al.*)

Electronic behavior is interesting but complex
Electronic structure linked with magnetic structure

→ Requires detailed knowledge of magnetic structure down to 5Å length scales

→ Experiments at SNS

Giant magnetoresistance in ferromagnet-superconductor superlattices, V. Peña, Z. Sefrioui, D. Arias, C. Leon, J. Santamaria, J.L. Martinez, S.G.E. te Velthuis, A. Hoffmann, Phys. Rev. Lett. 94 (2005) 057002(4).

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